

Æ. Lachenalii, but find the lowest leaves to be occasionally even tripinnate, and the leaflets are quickly rounded off at the end to an acute angle. I suspect that Mr. Ball is not acquainted with the radical leaves of seedling plants or young offsets: they are once or twice pinnate, with ovate or wedge-shaped, obtusely inciso-apiculato-crenate segments.

It only now remains for me to add, that I fully concur with my friend in the observations with which he concludes his paper, but think that the position, form, and relative size of the radical knobs are of more value for the discrimination of species than they appear to possess in his estimation.

St. John's College, Cambridge, April 25, 1844.

XIV.—On *Cardinia*, *Agassiz*, a Fossil Genus of *Mollusca* characteristic of the *Lias*. By H. E. STRICKLAND, M.A., F.G.S.

THERE are few groups of fossils which, both in their generic and specific relations, have been involved in greater confusion than the very natural and characteristic genus of which I am about to speak. Having resided for some years in a locality where several species of this genus abound, and having, by the examination of many hundreds, I might say thousands of specimens, aided by the kindness of Mr. J. Morris, author of the valuable 'Catalogue of British Fossils,' been enabled to trace them through their several varieties, and thus to circumscribe the boundaries of the species, I hope to correct some of the errors into which other authors have fallen.

The genus of Mollusks in question is evidently most nearly allied to *Astarte*, Sow. (*Crassina*, Lamarek), a genus which most authors agree in placing among the *Veneridæ*. From the great strength of the shell, single valves are often preserved in a perfect state, and we are thus enabled to ascertain all its characters with an accuracy that is rarely attainable in fossil bivalves, especially of the older formations. The genus may be described in general terms as an *Astarte* with the addition of very strong lateral teeth. The shell is longitudinally oval, very thick, equi-valve, inequilateral, perfectly closed; the hinge very strong; the right valve with two oblique converging cardinal teeth as in *Astarte*, but these teeth are flat, and only divided by a slight groove, which is sometimes obsolete. Below these teeth and immediately behind the lunule is a depression extending in front of the anterior lateral tooth, with a corresponding elevation in the left valve, in which the true cardinal teeth are almost wholly obsolete. Above the cardinal teeth in both valves is a deep narrow groove, evidently for the reception of an external ligament, as in

Astarte. In front of the hinge is a deep and distinct lunule. The lateral teeth are remote and very strong; the anterior one of the right valve obtusely conical, the posterior one of the left valve elongated, and both mutually entering deep pits in the opposite valves. Umbones approximate. Muscular impressions very deep, placed immediately below the lateral teeth, their surfaces smooth; the posterior impression round, the anterior one ovate. Above the latter in both valves is a small oval detached muscular impression placed on the hinder surface of the lateral tooth, for the insertion of the retractor muscle of the foot. Pallial impression entire, parallel to the margin, which is not crenated. External surface of the shell more or less irregularly imbricated by the lines of growth. The geographical distribution of this genus is as yet confined to Northern Europe; its geological range is from the base of the lias up to the inferior oolite.

Several species of this genus were described by Sowerby in his 'Mineral Conchology,' under the genus *Unio*. They differ however from the whole of the *Unionidæ* in many respects, especially in the want of the small accessory muscular impression behind the anterior one (which occurs in the *Unionidæ*, and to which a branch of the retractor muscle of the foot is attached), in the presence of the lunule, in the shell not being nacreous, and in the habitat having been marine, as is sufficiently proved by the other fossil animals whose remains invariably accompany these shells.

M. Goldfuss has been no more successful than Mr. Sowerby in detecting the true generic relations of these shells, having in his 'Petrefacten' referred different species of them to the genera *Unio*, *Cytherea* and *Lucina*, without detecting the essential characters which distinguish them from all these genera.

M. Agassiz was the first to combine the different species of this group into one genus, though he failed to perceive that they are much more closely allied to the *Veneridæ* than to the *Unionidæ*. To this genus he gave the name of *Cardinia* in a paper read to the Helvetic Society at their meeting at Basle in 1838, and in 1840 he published the characters of the genus in his translation of Sowerby's 'Mineral Conchology.' In 1840 Mr. J. E. Gray gave the name *Ginorga* to this genus in the 'Synopsis of the British Museum,' p. 154; but this mere name, destitute alike of etymology and of definition, can have no claim for adoption. In January 1841, M. de Christol defined a genus *Sinemuria* in the 'Bulletin de la Société Géologique de la France,' which from the characters assigned is evidently identical with the genus before us, though he errs in supposing the ligament to have been internal instead of external. Lastly, in March 1842 Mr. S. Stutchbury described this group in great detail in the 'Annals of Natural History,' and bestowed on it the name of *Pachyodon*, a name

which had been used four years before by M. von Meyer for a genus of Mammals.

It appears from this historical statement, that as M. Agassiz was the first to publish the characters of the genus, so his generic name *Cardinia* must supersede all later ones.

Some authors have been disposed to extend the geological range of this genus, by including in it those numerous species from the coal-measures which Sowerby and most other palæontologists have regarded as true *Unionide*. Whether Agassiz originally proposed this extension of the genus I am not aware, having never yet been able to meet with his translation of the 'Mineral Conchology,' in which the group is first defined; but in his last work on the subject, the 'Études critiques sur les Mollusques Fossiles,' he seems to regard *Cardinia* as exclusively confined to the lias and lower oolite. De Koninck however, in his 'Description des Animaux Fossiles du terrain houillier de la Belgique,' classes these coal-measure shells as *Cardiniae*, and prefixes a definition of the genus which seems to be chiefly copied from De Christol's definition of *Sinemuria*, and we may therefore conclude that De Koninck had not been able to examine the *interior* of the fossils which he describes. He seems to have made a compromise between the real characters of *Cardinia* and the erroneous statement of De Christol as to the *internal* ligament; for he says that the shell had *two* ligaments, one *internal* and the other *external*, a statement which I believe to be wholly incorrect.

Capt. Thomas Brown also seems to regard the coal-measure fossils as generically identical with the lias ones, since he has described, under Mr. Stutchbury's name *Pachyodon*, no less than twenty-six species of shells from the coal-measures, which he has illustrated with very accurate figures in the 'Annals of Natural History' for Dec. 1843, and in his own 'Fossil Conchology of Great Britain,' plate 73.

There are however many reasons for regarding as doubtful the supposed affinity between the Unioniform shells of the coal-measures and the true *Cardiniae* of the lias, although it must be admitted that there is much general resemblance in their external forms. In the *first* place, I believe no author has yet seen or described the *interior* of any of the coal-measure shells, and there is consequently no positive evidence whatever as to the structure of their hinges. *Secondly*, although the general characters of the muscular and pallial impressions, as exhibited by the casts in both these sets of species, are very similar, yet in the coal-measure shells the muscular impressions are much smaller and shallower than in those of the lias, and the lateral teeth, if present at all, are evidently much less developed. *Thirdly*, in conformity with this greater feebleness of the connecting muscles, we find that the

shells of the coal-measure fossils are much thinner and weaker than in those from the lias. *Fourthly*, the shells from the coal-measures rarely exhibit any trace of a lunule, and when present it is more diffused and indistinct than in the liassic species. *Lastly*, the *Cardinia* from the lias were wholly marine in their habits, while there are strong grounds for believing that the species from the coal-beds inhabited fresh, or at most brackish water. This is shown by the fact that these *Unio*-like shells are almost invariably found in the beds of shale accompanying the coal, and not in the really marine formations of the same age. Now whether we suppose the coal to have grown *in situ* like peat, or to have been washed by currents into certain localities (both which theories are no doubt true in certain cases), we cannot deny the coal to be a terrestrial production; and therefore when we find a particular family of mollusks constantly, and almost always exclusively, accompanying the beds of coal, we have a very strong presumption that these animals had a lacustrine or estuarine habitat.

It is true that in some cases, as in Coalbrook Dale, at Halifax, at Glasgow, and in Belgium, the coal-measures contain an admixture of these bivalves with various marine genera; but this does not necessarily prove them to be marine species, for they may either (as suggested by Mr. Prestwich in his memoir on Coalbrook Dale, 'Geol. Proceedings,' vol. ii. p. 405) have been washed down into an estuary and there become mixed with marine shells, or by a depression of the land the sea may have washed the marine shells into the marshes tenanted by these supposed freshwater species. And it is important to remark, that in the carboniferous limestone, a strictly marine formation immediately preceding, and in some cases alternating with the coal-measures, these peculiar bivalves rarely if ever occur.

For these reasons I think we ought to abstain from classing the shells of the coal-measures with the well-marked and clearly-defined genus *Cardinia* of the lias. I do not indeed mean to assert that the carboniferous group of shells really belong to the *Unionidæ*, where they were formerly classed, for they want the supplementary anterior muscular impression which distinguishes that family*; but I think they may be for the present regarded as a distinct family, probably lacustrine, and possibly allied to *Unionidæ*, but the precise characters of which, and especially the structure of the hinge, are as yet unascertained. Perhaps Dr. Carpenter, whose researches on the microscopic structure of shells have opened to us a new element for the determination of fossil

* Mr. G. B. Sowerby, in his 'Genera of Recent and Fossil Shells,' states that he could find *no difference* between the casts from the coal-measures and those which he made from the inside of recent *Unios*, but he had perhaps overlooked the supplementary muscle of the latter.

Mollusca, may be able to throw further light on the affinities of these ambiguous yet characteristic fossils.

Confining our attention therefore to the shells of the lias and lower oolite, we will proceed to examine the species of *Cardinia* which really exist in nature, as well as those which have been described in books.

I. *Ascertained species of Cardinia.*

1. *CARDINIA LISTERI, Sow. (sp.)*

Donax? Park. Org. Rem. pl. 13. f. 7.

Unio Listeri, Sow. Min. Con. pl. 154. f. 1, 3, 4.

Pachyodon Listeri, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 9. f. 1, 2.

Var. 1. Subelongate.

Cytherea latiplexa, Goldf. Petref. pl. 149. f. 6.

Unio hybrida, Sow. Min. Con. pl. 154. f. 2.

Pachyodon hybridus, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 9. f. 3, 4.

Cardinia hybrida, Agass. Et. Crit. Moll. pl. 12.

Var. 2. Subcompressed.

Cytherea lamellosa, Goldf. Petref. pl. 149. f. 8.

Var. 3. Lines of growth very numerous.

Pachyodon imbricatus, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 9. f. 5, 6.

Var. 4. Small-sized (probably young).

Pachyodon cuneatus, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 10. f. 11, 12.

Var. 5.

Cardinia amygdala, Ag. Et. Crit. Moll. pl. 12. f. 10—12.

Formation: lower lias.

Localities: Whitby, Yorkshire; Grantham; Langar, Nottinghamshire; Cropthorn, Defford and Eckington, Worcestershire; Frethern, Gloucestershire; Wurtemberg.

In Worcestershire and Gloucestershire this species is very abundant in a zone of the lower lias, about 150 feet above the base of that formation. Single valves are frequent. It is subject to much variation in the thickness of the shell, the frequency and regularity of the imbrications, and the length or shortness of the posterior extremity. Having examined a very extensive series of specimens, I have little doubt of the correctness of the above synonyms.

2. *CARDINIA CRASSISSIMA, Sow. (sp.)*

Unio crassissima, Sow. Min. Col. pl. 153.

Pachyodon crassissimus, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 9. f. 7.

Lower oolite: Dundry; Wick near Bath.

Marlstone: Dumbleton, Worcestershire.

3. *CARDINIA CRASSIUSCULA*, Sow. (sp.)

Unio crassiusculus, Sow. Min. Con. pl. 185 ; Zieten, Verst. Wurt. pl. 60. f. 1.

Pachyodon crassiusculus, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 9. f. 8.

Pullastra antiqua, Phill. Geol. Yorksh. pl. 13. f. 16.

Var. 1. Small-sized, perhaps young.

Cardinia elliptica, Ag. Et. Crit. Moll. pl. 12. f. 16, 17.

Var. 2.

Cardinia similis, Ag. Et. Crit. Moll. pl. 12. f. 23.

Formation : lias.

Localities : Pocklington and Robin Hood's Bay, Yorkshire ; Nottinghamshire, Gloucestershire, Somersetshire.

Wurtemberg ; Stuttgart. Var. 1. Argovie ; var. 2. Soleure.

After a careful comparison of specimens, I have little doubt of the specific identity of the above references.

4. *CARDINIA LANCEOLATA*, Stutchb. (sp.)

Pachyodon lanceolatus, Stutchb. in Ann. Nat. Hist. vol. viii. p. 484.

Formation : lower lias.

Locality : Robin Hood's Bay, Yorkshire.

The figure intended for this species by M. Agassiz was taken from a specimen of *C. attenuata* which I sent him.

5. *CARDINIA ATTENUATA*, Stutchb. (sp.)

Pachyodon attenuatus, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 10. f. 13, 14.

Cardinia lanceolata, Ag. Et. Crit. Moll. pl. 12^o. f. 1—3.

Formation : top of lower lias, just below the marlstone.

Localities : Hewlets near Cheltenham ; Bourton-on-the-Water, Gloucestershire.

M. Agassiz's figure above-quoted is taken from a specimen which I sent him, and I am therefore satisfied that it belongs to the present species.

6. *CARDINIA CONCINNA*, Sow. (sp.)

Unio concinnus, Sow. Min. Con. pl. 223. f. 1, 2 ; Zieten, Verst. Wurt. pl. 60. f. 2 to 5 ; Goldf. Petref. pl. 132. f. 2 ; Bronn, Lethæa Geogn. p. 361.

Pachyodon concinnus, Stutchb. in Ann. Nat. Hist. vol. viii. pl. 10. f. 15, 16.

Cardinia concinna, Ag. Et. Crit. Moll. pl. 12. f. 21, 22.

Formations : marlstone and lias.

Localities : Yorkshire ; Langar, Nottinghamshire ; Daventry, Northamptonshire ; Saltford and Weston near Bath ; Wurtemberg, Fachsenfeld ; Moggingen ; Staffelegg in Argau.

This is the largest species of the genus. I have a specimen

from the marlstone of Byfield in Northamptonshire which is $5\frac{1}{2}$ inches long by 3 inches broad.

7. *CARDINIA OVALIS*, *Stutchb.* (sp.)

Lucina lævis, Goldf. Petref. pl. 146. f. 11.

Pachyodon ovalis, *Stutchb.* in Ann. Nat. Hist. vol. viii. pl. 10. f. 17, 18, 19.

Cardinia unionides, Ag. Et. Crit. Moll. pl. 12". f. 7—9.

Var. 1.

C. cyprina, Ag. Et. Crit. Moll. pl. 12". f. 4—6.

Formation : lower lias.

Localities : Dunhamstead and Coltknap hill, Worcestershire ; Ashleworth and Frethern, Gloucestershire ; Watchet, Somersetshire ; Blumenroth, Coburg.

M. Goldfuss's specific name *lævis* is prior to the other two ; but as it is founded on an erroneous identification with the *Corbis lævis* of Sowerby, which is a very different shell, I retain Mr. Stutchbury's name *ovalis*. The two supposed species figured by M. Agassiz are both founded on specimens which I sent to that learned naturalist myself, and I am therefore able to identify them positively with the present species. In Worcestershire this fossil abounds about 100 feet above the base of the lower lias. Single valves are very rare.

8. *CARDINIA SULCATA*, *Ag.*

Cardinia sulcata, Ag. Et. Crit. Moll. pl. 12. f. 1—9.

Formation : "Calcaire à Gryphites."

Locality : Soleure.

Judging from the figure and description, the above seems to be a distinct species.

9. *CARDINIA APTYCHUS*, *Goldf.* (sp.)

Cytherea aptychus, Goldf. Petref. pl. 149. f. 7.

Formation : lias.

Locality : Amberg.

I have seen and examined specimens of all the above species except nos. 8 and 9.

II. *Species referable to this genus, but whose specific characters require further investigation.*

1. *Pachyodon abductus*, *Stutchb.* in Ann. Nat. Hist. vol. viii. pl. 9. f. 9, 10.

I think this is probably one of the numerous varieties of *C. Listeri*. I agree with M. Agassiz that it is not the *Unio abductus* of Phillips.

2. *Cardinia oblonga*, Ag. Et. Crit. Moll. pl. 12. f. 13—15.

From the lower oolite of Normandy. Described from a cast,

an authority on which it must be very unsafe to found *specific* distinctions.

3. *Cardinia lævis*, Ag. Et. Crit. Moll. pl. 12". f. 13—15.

From Mulhausen. It is not the *Lucina lævis* of Goldfuss. Perhaps a variety of *C. Listeri* or *crassiuscula*.

4. *Cardinia securiformis*, Ag. Et. Crit. Moll. pl. 12". f. 16—18.

From Soleure; described from a cast, and perhaps only a variety of *C. concinna*.

5. *Sinemuria Dufrenii*, De Christol, Bullet. Soc. Géol. de la France, Jan. 11, 1841.

From "fer oligiste" of Semur. It is impossible to say, from the brief description given, whether this shell be a distinct species or not.

6. *Unio depressus*, Zieten, Verst. Wurt. pl. 61. f. 1.

From Dejerloch near Stuttgart. Probably referable to variety 1. of *C. Listeri*.

III. Species apparently referable to other genera.

1. *Venulites trigonellaris*, Schloth. Petref. p. 198; *Cytherea trigonellaris*, Goldf. Petref. pl. 149. f. 5.

From the lias of Alsace; perhaps not a *Cardinia*.

2. *Unio abductus*, Phillips, Geol. of Yorksh. pl. 11. f. 42.

From inferior oolite of Glaizedale. Possibly a *Cardinia*, but M. Agassiz regards it as a *Gresslya*.

3. *Cardinia quadrata*, Ag. Et. Crit. Moll. pl. 12". f. 10—12.

From lias of Lower Rhine. The above figure appears to represent an *Astarte*, and much resembles *A. lurida*, Sow.

4. *Unio Listeri*, Goldf. Petref. pl. 132. f. 1.

This seems to be the *Amphidesma donaciforme* or *rotundatum* of Phillips, and belongs to the genus *Gresslya*, Agassiz.

5. *Unio uniformis*, Sow. Min. Con. pl. 33. f. 4.

6. *Unio acuta*, Sow. Min. Con. pl. 33. f. 5, 6, 7.

The last two species, said by Sowerby to be from the middle oolite, are referred to *Cardinia* by Agassiz, in his translation of the 'Mineral Conchology.'

7. *Pachyodon hamatus*, Brown in Ann. Nat. Hist. vol. xi. pl. 16. f. 6.

From Oxford clay of Gristhorpe Bay, and certainly not a *Cardinia*.

8. *Pachyodon vetustus*, Brown in Ann. Nat. Hist. vol. xi. pl. 16. f. 7.

From shale at Gristhorpe Bay, and probably not a *Cardinia*.

9. *Unio striatus*, Goldf. Petref. pl. 132. f. 3.

From coral rag, Nattheim.

10. *Unio liasinus*, Zieten, Verst. Wurt. pl. 61. f. 2; Bronn, Lethæa Geogn. pl. 19. f. 17.

From Fildres near Stuttgart. This is evidently a *Gresslya*, allied to *Amphidesma rotundatum*, Phillips.

XV.—*On the Marine Algæ of the vicinity of Aberdeen.* By G. DICKIE, M.D., Lecturer on Botany in the University and King's College of Aberdeen*.

[Continued from vol. xiii. p. 335.]

[With a Plate.]

PREVIOUS to entering on the remaining species of the olive-coloured Algæ found in this vicinity, it will be necessary to direct attention to the difference usually understood between the reproductive bodies called *spores* and *sporidia*.

The remarks already made on the *acrospirms* (*sporidia*) of *Fucus*, &c., and the accompanying figures, will sufficiently explain their structure; it must be observed, that up to the time of maturity they are enclosed in cells (*asci*), from which, when ripe, they are readily emitted. It is more than probable, however, that there are instances in which there is an intimate adhesion between the *sporidia* and their *asci*, so that both drop off together.

The observations recorded in the first part of this communication, on the development of the seeds of *Fucus serratus*, will explain the nature of *spores*; the latter are not necessarily enclosed in cells up to the time of maturity, but usually become free.

A difference exists in many Algæ between the appearance of the contents of the *spores* and *sporidia*: in the latter, the granular matter has a tendency to cohere in masses, which often assume a definite arrangement; the contents of the *spores* are more abundant, so much so that these bodies are generally dark-coloured and almost opaque,—hence the expression *Melanospermeæ*, and the granular matter probably never (?) assumes a definite arrangement.

SPOROCHNOIDÆ.

Desmarestia ligulata, Lamour.—This species appears to be of rare occurrence, strictly confined to deep water, and only found cast up after storms. The first specimens were found by Dr. Andrew Fleming in October last, on the beach near Don mouth,

* Read before the Botanical Society of Edinburgh, 11th April 1844.